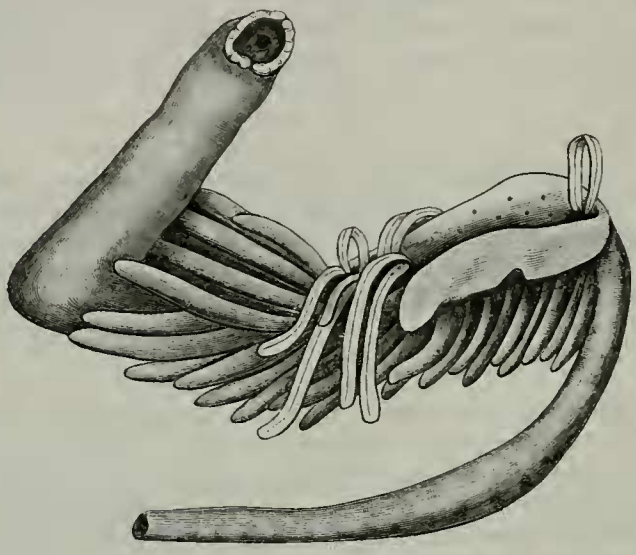
which, however, must have acted so as to prevent the escape of food into the abdominal cavity.

Mr. Day likewise exhibited a portion of the sifting-apparatus of the Basking Shark (*Selache maxima*) which had been captured off Dendmans on May 6th. These branchial combs or teeth had been



Intestines of diseased Trout.

fully described by Prof. Turner. The food taken from the Shark's stomach was exhibited, and had the appearance of "red stuff like bruised crabs, or the roe of the Sea-Urchin, as described by Low," and in the pharynx were quantities of sessile-eyed crustaceans, mostly Amphipoda and Copepoda in a fresh condition, and evidently what the substance in the stomach originally consisted of, as was further proved by a microscopic examination. The specimen was a female over eleven feet long, and the longest tooth in its jaws was 0·09 of an inch.

The following papers were read :—

1. Notes on the Pinnipedia.

By St. George Mivart, V.P.Z.S.

[Received April 16, 1885.]

To the question whether or not the group of Pinnipeds should form a distinct order of Mammalia, modern science adds that concerning their genetic affinities. This latter inquiry suggests another question, namely, the question whether the group is genetically

homogeneous, or whether it may have had more than one source. If the latter question can be settled, it then remains but to inquire from what source or sources the whole group was derived.

That the group is subdivisible into three main subgroups has been long recognized.

Mr. H. N. Turner, in his classical paper on the foramina of the Base of the Skull [1], gives to the group the value of a family, *Phocidæ*, which he subdivides and characterizes as follow [2]:—

Fam. Phocidæ.

Molars all similar in structure.

Subfamily Arctocephalina.

A postorbital process. An alisphenoid canal; mastoid process strong and salient, standing aloof from the auditory bulla.

Otaria. *Arctocephalus.*

Subfam. Trichechina.

No postorbital process. A distinct alisphenoid canal. Mastoid process strong and salient, its surface continuous with the auditory bulla.

Trichechus.

Subfam. Phocina.

No postorbital process. No alisphenoid canal. Mastoid process swollen and seeming to form part of the auditory bulla.

Morunga. *Lobodon.*
Cystophora. *Leptonyx.*
Halichœrus. *Stenorhynchus.*
Ommatophoca. *Phoca.*

Professor Flower, in his paper on the Classification of the Carnivora [3], says:—"With regard to the group of Seals, which I look upon as essentially belonging to the same ordinal division of the Mammalia as the animals hitherto treated of [*i. e.* the fissipedal Carnivora], the differences of the cranial characters of the three natural families into which they are divisible, the *Otariidæ*, *Trichechidæ*, and *Phocidæ*, are so well described by Mr. Turner that I need only refer to his paper for them. But I must add that I cannot agree with him when he says, 'I have not seen in the Seals anything which, in my opinion, warrants their approximation to any of the other families more than another,' or in his placing them and the three divisions of the terrestrial Carnivora as primary groups of equal value. The differences between the Seals and the terrestrial Carnivora both in teeth and limbs are much greater than any found between different members of the latter group. They should therefore constitute, in my opinion, a

[1] P. Z. S. 1848, p. 63. [2] *L. c.* p. 88. [3] See P. Z. S. 1869, p. 34.

distinct suborder, the Æluroid, Cynoid, and Arctoid Carnivora being united to form the other suborder. I think moreover that there is not the slightest question that their cranial characters indicate most strongly their approximation to the Arctoid type, as has often been noticed before on other grounds (De Blainville says, 'Les Ours, dont les rapports avec les Phoques ont été sentis de tout temps et même par Aristote,' Ostéographie, tome ii. p. 49). Indeed their skulls seem to be simply a further modification of this type, showing resemblances to the true Bears on the one hand, and the Otters on the other."

Before stating my own general conclusions, I will proceed to give my notes upon the various genera of Pinnipeds.

Phoca[1].—This genus consists of half-a-dozen or a few more species, confined to the northern arctic and temperate regions of the Old and New Worlds, including the Aral and Caspian Seas and the coasts of Japan. *P. vitulina* is found in both hemispheres. They have the palms and soles hairy, five well-developed claws to each foot, those of the manus being the broader and more curved. The hind limbs are constantly extended backwards, and cannot be turned forwards. There is no external ear and no scrotum. The toes of the pes do not differ quietly in length, the first and fifth not greatly exceeding the others. There are 14 or 15 dorsal, 5 lumbar, 4 sacral, and from 11 to 15 caudal vertebræ.

The skull presents the following general characters:—

The premaxilla is much separated from the frontal by a more or less wide junction of the nasal with the maxilla. The nasals are not generally, if at all, anchylosed together, and they join the premaxillæ. There is no lachrymal foramen. The infraorbital foramen is of moderate size, or rather large. There is no distinct foramen rotundum, one opening representing both it and the sphenoorbital fissure. Sometimes there are defects of ossification between the basisphenoid, alisphenoid, and pterygoid. There are one or two large openings in the palatine, representing the spheno-palatine foramen, with defects of ossification above it between the frontal, maxilla, and palatine. There are also, generally, defects of ossification in the basisphenoid and basioccipital. The alisphenoid is joined by a long descending process of the parietal. There is no postorbital process from the frontal, and the zygomatic postorbital process is formed partly by the malar and partly by the squamosal. There is a large crista galli. The cerebellar fossa of the petrosal is very deep. The bulla is dense and undivided, traversed by a carotid canal the posterior aperture of which is on the hinder surface of the bulla. There is, in most cases, hardly any paroccipital process. The mastoid is prominent and forms an outwardly directed

[1] Linn. Fn. Suec. ii. p. 2, 4; Syst. Nat. 12, i. p. 56; Schreb. Säug. vol. vii. p. 17; Buffon, Hist. Nat. xiii. p. 333, pl. 45, and Suppl. vi. pl. 46; Gray (*Callocephalus*, *Pagomys*, *Pagophilus*, *Halicyon*, and *Phoca*), Catalogue of Seals and Whales in Brit. Mus. pp. 20–32; J. J. Allen, North Amer. Pinnipeds, pp. 412, 557, &c.; De Blainville, Ostéog., *Phoca*; Cuvier, Ossem. Foss., Atlas, vol. ii. pl. 219.

process, behind which the bone is rounded. The stylomastoid foramen lies in a deep groove which divides the mastoid from the bulla. The meatus auditorius externus is produced outwards, but its lower lip inclines so much upwards posteriorly that the aperture is made to look more forwards than upwards, and the outer end of the lip may be produced a little forwards in front of the aperture. There is a postglenoid foramen. The posterior palatine foramina are situated behind the middle of the palate. The pterygoid has a distinct hamular process. The basis cranii has a surface bent convex downwards between the occipital foramen and the presphenoid. Venous canals traverse the inside of the exoccipitals and open on the inner side of either occipital condyle. The mandible has a distinct subangular process, and the angle is pressed up very near the condyle. The symphysis may be long or short.

Dentition:—I. $\frac{3}{2}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{1}{1}$=34.

Molars, except the first, with two roots. Each upper molar has a principal cusp with one or two accessory cusps behind, and sometimes one in front of it. The lower molars have each a principal cusp with one, sometimes two, accessory cusps in front of it, and generally two behind it.

In *P. vitulina* the hinder margin of the palate is V-shaped, the apex being forwards. The suture between the palatines and maxillæ forms a straight transverse line. The teeth are rather large and multicuspidate.

In *P. grœnlandica* the palate has a straight, transverse, hinder margin. There is sometimes a distinct pterygoid fossa. The paroccipital process may form a marked, nipple-like projection. The teeth are more simple than in *P. vitulina*.

In *P. barbata* the maxilla has a swollen outer surface; venous canals open inside the upper margin of the foramen magnum, and a curious ridge runs downwards and forwards across the squamosal and parallel with the hinder root of the zygoma. The meatus auditorius externus looks mainly upwards. The paroccipital process is rather prominent. The palate extends far back, and has an evenly concave hinder margin. The two parietals form a small wedge-shaped process which advances between the hinder margins of the two frontals.

Halichœrus[1].—This genus contains but one species, *H. gryphus*, which inhabits the coasts of Scandinavia and the British Isles. Its palms and soles are hairy, and it has five well-developed claws on each foot, those of the manus being the broader and more curved. There are 15 dorsal, 5 lumbar, 4 sacral, and about 14 caudal vertebræ.

In the skull the same characters are found as those already attributed to *Phoca*, except that there is a more decided defect of ossification between the ali- and basisphenoids and the pterygoid. Moreover the palatine foramina are much behind the middle of the palate.

[1] Fabric. Skrivt. af Naturh. Selsk. i. p. 167, tab. 13. fig. 4; Nilsson, Vet. Akad. Handl. p. 377, tab. 34. figs. 1 & 2; Bell, Brit. Quad. p. 278; Gray, Cat. Brit. Mus. p. 33; Schreber, Fortgesetzt Wagner, vii. p. 12; De Blainville, Ostéogr. *Phoca*; Allen, North Amer. Pinn. p. 682.

It is noteworthy that the mastoid process is not so large relatively in certain old individuals as in younger ones. The palate has a concave hinder margin. The anterior nares are very high.

Dentition :—I. $\frac{3}{2}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{1}{1}$=34.

Molars large, conical and simple, generally without accessory cusps. Their apices are slightly recurved, and the anterior and posterior edge of each is rather sharp. All have but a single root, save the true molars and the fourth upper premolar. It is only these three teeth which ever have accessory cusps.

Stenorhynchus [1].—This genus consists of two species, confined to the Antarctic and Southern oceans. The hind feet are almost or quite clawless, and the first and fifth toes greatly exceed the others in length. There are 14 or 15 dorsal, 6 or 5 lumbar, 3 sacral, and 12 or 14 caudal vertebræ.

The skull presents the characters already enumerated as occurring in *Phoca*, except that the premaxillæ do not attain, or hardly attain, the nasals, which are more or less completely anchylosed together. There may be but very small defects of ossification in the occipital. The long descending process of the parietal hardly attains the alisphenoid. The cerebellar fossa of the petrosal is small. There is a moderate paroccipital process. The optic foramina may (they do in *S. leptonyx*) unite inwards to open into the cranial cavity by a single and median aperture. The hamular processes of the pterygoids may be long, as in *S. carcinophagus*, or hardly any, as in *S. leptonyx*. The bulla may not be so prominent as in *Phoca*. The glenoid foramen is in the form of a small fissure, placed rather on the inner side of the postglenoid process. There is a large preorbital process on the maxilla, a structure which is only represented by a rudiment in *Phoca* and *Halichœrus*, so far as I have seen [2]. The palate is strongly notched behind medianly. There is no subangular process to the mandible, and the angle may be almost obsolete, though marked in *S. carcinophagus*, while the coronoid process is lower than in *Phoca* and *Halichœrus*.

Dentition :—I. $\frac{2}{2}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{1}{1}$.

The molars (which are, except the first, two-rooted) may, as in *S. leptonyx*, have three pointed cusps well separated, the middle being the largest and slightly recurved towards the apex, the apices of the other two being inclined towards the long cusp, or else, as in *S. carcinophagus*, they may have subcompressed, much elongated crowns with a principal recurved cusp with a small one in front of it, and one, two, or three accessory cusps behind it, the principal cusp being somewhat bulbous at the apex.

[1] Gray, Voy. of Erebus & Terror, Mam. i. p. 2, pls. 1 & 2; Cat. Brit. Mus. p. 15; De Blainville, Ostéographie; Schreber, Fortg. Wagner, vii. pp. 36–38; Cuvier, Oss. Foss. Atlas, vol. ii. pl. 219. fig. 2. This is the *Ogmorhinus* of Peters, Monatsbr. K. P. Akad. Wissen. Berlin, 1875, p. 393, note; Allen, N. Am. Pinniped. p. 466. It is also the *Lobodon* of Gray, Voy. of Erebus & Terror, and Catalog. Brit. Mus. p. 8, and of Allen, N. Amer. Pinnipeds. p. 466.

[2] A rudiment of this process is also found in *Lutra* and *Ursus*, but in no other land Carnivora, so far as I have observed.

Leptonyx[1].—A genus of one species inhabiting the Antarctic seas. Its hind feet have rudimentary claws, with the first and fifth toes much longer than the others.

The skull generally resembles that of *Phoca*. The premaxillæ are widely separated from the frontals, but just attain the nasals, which are anchylosed together and prolonged backwards as a slender process between the two frontals. The infraorbital foramen is of moderate size. There are defects of ossification in the basi- and ex-occipitals and between the basioccipital and basisphenoid; also between the frontal, maxilla, and palatine, and a very large single sphenopalatine foramen. The anterior nares are neither very wide nor extending far backwards. The alisphenoids and parietals have a rather wide junction. There is a very small true paroccipital process just behind the foramen lacerum posterius, but besides this a vertical ridge juts outwards near the margin of the exoccipital, where it joins the mastoid. The postglenoid foramen is minute, but the condyloid foramen is conspicuous. The palatine foramina open about the antero-posterior middle of the palate. The pterygoid has an outwardly tending hamular process. The basis cranii is convex below as in *Phoca*. The maxilla develops no preorbital process. The posterior margin of the palate is concave. The mandible is slender, and has no subangular process, but the coronoid rises decidedly above the condyle. The symphysis is rather long.

Dentition:—I. $\frac{2}{2}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{1}{1}=32$.

The molars are small, each with a large conical cusp proceeding from a cingulum. There are no distinctly developed accessory cusps except in the last, or last two, lower molars, but there is a constant tendency to develop an accessory cusp in front of and behind the principal cusp.

Ommatophoca[2].—This genus contains one species, which inhabits the Antarctic Seas. Here the hind feet are devoid of claws, and the first and fifth toes are much longer than the others. The claws on the fore feet are quite rudimentary.

In the skull we here find premaxillæ which do not attain the nasals, so that the maxillæ help to bound the anterior nares. The nasals are completely anchylosed together, and form a very long isosceles triangle, the long angle being wedged in between the frontals, while anteriorly the maxillæ join the nasals. The orbits are immense, and give a very distinctive appearance to the skull, and the zygomata are strongly developed and much arched downwards. The infraorbital foramen is rather small. The condyloid foramen is conspicuous. The lower postorbital process is formed by both the malar and squamosal, as in all the genera hitherto noticed. In

[1] *Phoca leopardina*, Jameson Weddell, Voy. South Pole, i. pp. 22, 24, 134.
Stenorhynchus Weddelli, Lesson, Mam. 1827, p. 200.
Leptonyx Weddellii, Schreber, Fortg. Wagner, vii. p 39; Gray, Cat. Brit. Mus. p. 11, Erebus & Terror, pl. 5.
Leptonychotes Weddelli, Allen, N. Amer. Pinniped. p. 467.

[2] Gray, Zool. Erebus and Terror, Mamm.; Cat. Seals Brit. Mus. p. 13; Schreber's Fortgesetzt Wagner, vii. p. 40; Allen, N. Amer. Pinnipeds, p. 467.

addition to this, however, there is a faint trace of a frontal post-orbital process. The anterior nares do not extend far backwards. The palate is prolonged backwards behind the last molars, and its hinder margin is slightly concave. The palatine foramina open on its hinder half. There is hardly any true paroccipital process, but, as in the last-noticed genus, a vertical ridge near it projects backwards and away from the bulla. The mastoid is prominent, and its prominence is continuous with that of the squamosal above the external auditory meatus, immediately above which opening is a great antero-posteriorly extending bony swollen prominence. The meatus opens between the outwardly projecting mastoid and the postglenoid process, so that practically its lateral walls, but not its floor, are prolonged outwards. There is a chink-like postglenoid foramen. The basis cranii is always level, but slightly convex antero-posteriorly. The mandible has no subangular process, but in the place where it should be the bone is rounded. The coronoid is pointed, but small and low, hardly rising above the condyle. The maxilla develops a preorbital process. The symphysis is not prolonged.

Dentition:—I. $\frac{2}{2}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{1}{1}$=32.

The molars are very small, and have pointed, recurved crowns, mostly with a marked posterior accessory cusp and sometimes with one in front also.

Monachus[1].—This genus, of one species from the Mediterranean and Black Seas and the Atlantic Ocean about Madeira and the Canary Isles, resembles the three preceding genera in having the nails of the hind feet rudimentary, and the first and fifth toes greatly longer than the others. The nails on the fore feet are also rudimentary in this genus.

There are 15 dorsal, 5 lumbar, 2 sacral, and 11 caudal vertebræ.

The skull in its main characters resembles that of *Phoca*. The crista galli and cerebellar fossa of the petrosal are rather larger. The condyloid foramen is distinct, and placed midway between the condyle and the foramen lacerum posterius. There is a distinct preorbital process on the front rim of the orbit and developed from the maxilla. The nasals are not anchylosed together, and the premaxillæ ascend to meet them. The palate is concave behind, and its concave border is medianly notched. I have observed no defects of ossification in the basi- or exoccipitals, but (as in *P. barbata*) a venous channel traverses the supraoccipital opening by transverse apertures above the foramen magnum and inside its margin. There is a very large aperture on either side of the basis cranii bounded by

[1] *Phoca monachus*, Hermann, Beschäft. d. Berlin. Gesell. natur. Freunde, iv. 1779, p. 456, pl. 12, 13.
Phoque à ventre blanc, Buffon, Hist. Nat. Supp. vi. pl. 44; Cuvier, Oss. Foss. Atlas, vol. ii. pl. 218.
Monachus mediterraneus, Nilsson, Kong. Vet.-Akad. Handl. Stockholm (1837), p. 235.
Leptonyx monachus, Schreber's Fortg. Wagner, vii. p. 40.
Monachus albiventer, Gray, Cat. Seals Brit. Mus. (1866) p. 17; Allen, N. Amer. Pinnipeds, p. 465.

the pterygoid, palatine, presphenoid, and basisphenoid. There is a large paroccipital process and a considerable mastoid process. The meatus auditorius externus is prolonged well outwards, its lip is completed in front. The considerable palatine foramina are placed at about the antero-posterior middle of the palate. There is no angular process of the mandible near the condyle, but only a single process, which seems to correspond with the subangular process of those Seals which have both these processes. The coronoid process rises well above the mandibular condyle.

Dentition :—I. $\frac{2}{2}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{1}{1}$=32.

The molars are two-rooted except the first, which, with the last, is smaller than the others. The incisors are notched transversely on the inner side of the crown. The canines are large. The molars have strong conical crowns with only slightly developed accessory cusps from a strong cingulum, the inner part of which is well developed.

All foregoing genera *Monachus*, *Ommatophoca*, *Leptonyx*, and *Stenorhynchus* agree together and differ from the genera *Phoca* and *Halichœrus* in having only four upper incisors; nails of pes rudimentary or absent, and the first and fifth digits of that extremity greatly exceeding the others in length. The six genera then may be arranged in two groups thus respectively characterized and named *Phocinæ* and *Stenorhynchinæ*, as has been done by Professor Flower [1].

Cystophora [2].—This genus of one species, of the North Atlantic and Arctic seas, is characterized by having the dorsal facial skin of the male capable of distension by the inflation of a sac which underlies it and is connected with the nostrils. The distended skin thus forms a sort of hood covering the dorsal part of the head. As in the *Stenorhynchinæ*, the first and fifth toes exceed the others. They also have prolonged cutaneous lobes. The nails are tolerably developed in all the extremities. There are 15 dorsal, 5 lumbar, 3 sacral, and 14 caudal vertebræ.

In the skull the premaxillæ do not rise to the nasals. The latter are small and not anchylosed together. The orbits are very large. The anterior nares are very wide, especially towards their upper part. The maxilla develops a small preorbital process. There is a large crista galli, but a small cerebellar fossa to the petrosal. There is a moderate-sized suborbital foramen, and there may be a deep fossa beneath or external to it, as is sometimes the case in *P. grœnlandica*. I have observed no defects of ossification between the pterygoid, palatine, and adjacent bones. If there are any defects of

[1] See his paper on the Mammalia in the Encyc. Brit. vol. xv. p. 443.

[2] *Phoca cristata*, Erxleben, Syst. Nat. p. 590; Fabric. Skrivt. af Naturh. Selsk. i. 2, p. 120, tab. 12. fig. 2; Desm. Mam. p. 241; Harlan, Fauna N. Y. p. 106.

Phoca mitrata, Cuvier. Oss. Foss., Atlas. ii. pl. 219. fig. 3.

Cystophora cristata, Nilsson, Vet. Akad. Handl. 1837; Gray, Voy. Erebus and Terror, Mamm. p. 4, Cat. Seals Brit. Mus. (1866) p. 40; Schreber, Fortgesetzt Wagner, vii. p. 48; Allen, N. Amer. Pinnipeds, pp. 462, 465, 724.

Phoque à Capuchon, Buffon, Hist. Nat. Supp. vi. p. 324.

ossification in the basi- and exoccipitals they are very small. The palate is much prolonged behind the last molars, and its hinder margin is concave. The palatine foramina are situated in its hinder half. There are both a subangular and an angular process to the ascending ramus of the mandible, but both these processes are very small. The skull agrees generally with that of *Phoca*, in points not here mentioned.

Dentition :—I. $\frac{2}{1}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{1}{1}$=30.

Only the last upper molar has generally two roots. The roots of the molars are long and swollen; their crowns are small and rather plaited than lobed.

Macrorhinus[1].—This genus contains two species; one ranging the South Pacific, Indian, and Antarctic Oceans, and the other inhabiting the coasts of Mexico and Southern California. Here the claws of the manus are small, and those of the pes are quite rudimentary or altogether absent. The nose of the male has a short, dilatable proboscis. The first and fifth toes exceed the others and have prolonged cutaneous lobes.

There are 15 dorsal, 5 lumbar, 3 or 4 sacral, and 9–11 caudal vertebræ.

The skull has rather small nasals, which are separate and are not attained by the premaxillæ. The anterior nares are wide, especially dorsally, as in the last-described genus. The skull of this genus differs from all those of the genera yet noticed in that the posterior half of the petrosal and the condyloid foramina may look directly backwards. There is hardly any paroccipital process, and the mastoid process is only developed in old males. The palate may have a deeply concave hinder margin, or, being generally concave, may have a prominent process in its middle. The crista galli is large, but the cerebellar fossa of the petrosal is small. There are small venous channels in the supraoccipital which open on the dorsal margin of the foramen magnum. There is a deep groove behind the post-glenoid process, in which is a small glenoid foramen. There is a moderate suborbital foramen, with no deep fossa beneath it. I have observed no defects of ossification in the occipital or between the palatine and pterygoid and the sphenoid. The foramen ovale is thrown outside the vertical wall formed by the pterygoid, which passes backwards to join the petrosal.

There is a minute subangular process, pushed up very closely to the angular process, which itself is but little below the condyle.

Dentition :—I. $\frac{2}{1}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{1}{1}$=30.

[1] *Phoca leonina*, Linn. Syst. Nat. i. (1765) p. 38.
Phoca elephantina, Molina, Sagg. sul Stor. nat. del Chili (1782), p. 280.
Phoca proboscidea, Péron, Voy. aux Terr. Austr. ii. (1817) p. 34, pl. xxxii.
Cystophora proboscidea. Nilsson, Vet. Akad. Handl. (1837); Schreber's Fortgesetzt Wagner, vii. p. 42.
Morunga elephantina, Gray, Cat. Seals Brit. Mus. (1866) p. 38.
Macrorhinus leoninus, Allen, N. Amer. Pinnipeds, pp. 463, 466, 743. See also Flower, P. Z. S. 1881, p. 145, an important memoir.
Grand Phoque à museau ridé, Buffon, Supp. vi. p. 316.

The canines are large, and the outer upper incisors rather so. The molars are small and simple in structure.

These two genera last described form a third small group, *Cystophorinæ*, distinguished from the preceding by the dilatable skin of the facial region of the males, the simple or plaited molars, and by the presence of but two incisors in the lower jaw.

The three subfamilies themselves agree in having backwardly extended hind limbs, hairy palms and soles, no external ear, no scrotum, well-developed canines in each jaw, five molars on either side of either jaw, no alisphenoid canal, no frontal postorbital process or only a small rudiment of such a structure, and a mastoid, which rarely shows itself very distinct and apart from the auditory bulla.

Trichechus[1].—The Walrus inhabits the northern parts of both the Atlantic and Pacific oceans. As is well known, its hind feet are not constantly turned backwards (as in *Phoca* and its allies) but are turned forwards during progression on land, but there is still no external ear and no scrotum. The eyes are rather small. The manus has five very small nails, and its digits are of about equal length, as are also the digits of the feet, except that the fifth is somewhat the longest. It and the first have flattened nails; those of the other digits are large, compressed, and pointed. Cutaneous lobes project beyond the nails of the first and fifth digits.

There are 14 dorsal, 6 lumbar, 4 sacral, and about 18 caudal vertebræ.

The humerus is much longer than the radius and but little shorter than the tibia, thus so far differing greatly from the skeletal structure of *Phoca*.

The general characters of the skull are so familiar to naturalists that it would be waste of time and space to give them here. It differs from that of *Phoca* in having no defects of ossification in the occipital or the vicinity of the pterygoid. The suborbital foramen is large. The zygomatic postorbital process, which is large, is formed exclusively by the malar. There is no frontal postorbital process. The anterior nares are small, heart-shaped, and very far forwards. They are entirely bounded by the premaxillæ and nasals, which join, but the former are widely separated from the frontals, and the latter (nasals) are quadrate and separate. The palate is long and wide, and is concave both antero-posteriorly and transversely. It has a more or less concave hinder margin, and the pterygoid develops distinct depending hamular processes. There is an alisphenoid canal.

The bulla is undivided and very little prominent. The meatus auditorius externus is not much produced outwardly. There is no paroccipital process, but a very large and dense mastoid process, with

[1] *Rosmarus*, Gesner, Hist. An. Aquat. (1558) p. 249.
Odobænus, Linn. Syst. Nat. i. (1735) p. 59.
Trichechus, Linn. Syst. Nat. i. (1766) p. 49; De Blainville, Ostéog.: Cuv. Oss. Foss., Atlas, ii. pl. 219 bis; Schreber's Fortgesetzt Wagner, vii. p. 77; Murie, Trans. Zool. Soc. vii. (1871) p. 411, pls. 51–55; Gray, Cat. Seals Brit. Mus. (1866) p. 35, and P. Z. S. (1853) pp. 112–116; Allen, N. A. Pinnipeds, pp. 5–186.

only a faint indication of the groove which so deeply divides it from the tympanic in *Phoca*. I could detect no glenoid foramen. The basis cranii is but little curved antero-posteriorly, convex downwards. There is a large crista galli, but a small cerebellar process to the petrosal. The condyloid foramen is larger and nearer the condyle than in any of the genera hitherto noticed, and indeed than in any other Pinniped. The zygomata are small, projecting much outwards at the glenoid surface, and thence sloping inwards and forwards.

The mandible shows a faint trace of a subangular process. The angle itself is placed very high up and is rather inflected.

Young dentition:—I. $\frac{3}{3}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{1}{0}$.

Usual adult dentition:—I. $\frac{1}{0}$, C. $\frac{1}{1}$, P. $\frac{3}{3}$, M. $\frac{0}{0}$=18.

The enormous tusks and perfect simplicity and similarity of the other teeth, each with a flat grinding surface, have been again and again described.

Otaria[1].—According to Allen there are nine species of Otaries, which he arranges in six genera. Of these species the first and seventh come from the Galapagos and both coasts of South America; the second from the Auckland Islands; the third and sixth from both shores of the North Pacific; the fourth from California; the fifth from the Australian Seas; the eighth from the Cape of Good Hope; and the ninth from Australia, New Zealand, and the Antarctic Seas.

The Otaries turn the hind limbs forwards, and have a small external ear and also a scrotum, as is well known. The palmar and plantar surfaces are naked. The eyes are large. The nails are small or rudimentary, except those of the three middle digits of the pes.

There are 15 dorsal, 5 lumbar, 3 or 4 sacral, and 8–14 caudal vertebræ.

The skull has the anterior nares more vertical and nearer the anterior end of the skull than in the Seals. Otherwise the skull resembles that of *Phoca*, except in the following points:—There is a well-developed frontal postorbital process, and the postorbital process of the zygoma is formed by the malar only. There are no defects of ossification in the basioccipital and hardly any in the exoccipital; but there may be in the basisphenoid and in the place of the jugular and condyloid foramina. The petrotympanic is not bullate, but rugged and irregular, and the course of the carotid artery is plainly indicated along its inner border and is covered in beneath by a rather slight and imperfect ossification. The surface

[1] See Schreber, Fortg. Wagner, vii. p. 51; Péron, Voy. Terres Aust. ii. p. 4; Steller, Nov. Comm. Petrop. ii.; Nilsson, Vet.-Akad. Handl. (1837); Buffon, xiii. p. 53; Supp. vi. pp. 47, 48, 49; Cook's Second Voy. ii. p. 203; Quoy et Gaimard, Voy. Astrolabe, Mamm., and Zool. Uranie; Forster, Voy. round the World, ii.; Gray, Erebus and Terror, Cat. Seals Brit. Mus. (1866) p. 44; Clark, P. Z. S. 1873, p. 750, 1875, p. 650, 1878, p. 371, 1884, p. 189; Temminck, Fauna Japonica; Murie, Trans. Zool. Soc. vol. viii. p. 501; Gervais, Hist. Nat. Mamm. ii. p. 305; and especially Allen, N. Amer. Pinnipeds, p. 187.

of the bulla descends more and more mesiad, culminating in a ridge which is just external to this imperfect ossification. The lower lip of the meatus auditorius externus is not produced outwards; the mastoid process extends much further out and the meatus opens rather downwards. There is a very large paroccipital process, which is bent back and joins the very large mastoid process by a continuous undulating ridge, or wall, of bone.

The stylo-mastoid foramen is large, and not, as in the Seals, situated in a narrow groove between the mastoid and tympanic. There is a small postglenoid foramen. The palatine foramina are placed in the anterior half of the palate. There are great defects of ossification in the region of the spheno-palatine foramen. The basis cranii is curved, convex downwards, antero-posteriorly as in *Phoca*, but it is sharper and not so rounded. The alisphenoid is joined by a pointed prolongation of the parietal. There are small pterygoid fossæ and long hamular processes. There is an alisphenoid canal. There is a small or large preorbital process. A venous channel in the exoccipital opens inside the condyle. The condyloid foramen is larger than in the Seals.

The hinder part of the palate may be very deeply concave. The optic foramen opens singly into the cranial cavity. The cerebellar fossa of the petrosal seems generally very small. The premaxilla may develop a median process above the incisors. Besides enormous sagittal and lambdoidal ridges, there may be processes developed from the side of the skull like parts of a ridge extending backwards and downwards from the hinder part of the frontal to the lambdoidal ridge.

The mandible may have no subangular process or a small one, but there is a large "angle" very near the condyle and inflected as much as in any marsupial.

Dentition:—I. $\frac{3}{2}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{1 \text{ or } 2}{1}$, =34 or 36.

The molars have mostly but one root and a crown, which would be conical but that it is more or less compressed, with a cingulum whence more or less of an anterior and posterior accessory cusp may be developed. The outer incisors are rather large and shaped like canines. The other incisors are each divided at the summit into two pretty equal cusps by a transverse groove.

Otaria and *Trichechus* must be accepted as representing two groups of about the same value as that which includes the remaining genera. Thus we have the arrangement already put forward by Mr. Turner and Professor Flower, which may be shortly tabulated as follows:—

Pinnipeds with external ears and an alisphenoid canal	OTARIIDÆ. *Otaria.*
Without external ears, but with an alisphenoid canal	TRICHECHIDÆ. *Trichechus.*

With neither external ears nor alisphenoid canal	PHOCIDÆ.
Phocidæ with incisors $\frac{2}{1}$	CYSTOPHORINÆ.
A cranial pouch	*Cystophora.*
A proboscis	*Macrorhinus.*
Phocidæ with incisors $\frac{2}{2}$	STENORHYNCHINÆ.
Nasals not prolonged backwards	*Leptonyx.*
Nasals prolonged backwards. Orbits very large. Teeth very small	*Ommatophoca.*
Orbits not very large. Teeth much lobed	*Stenorhynchus.*
Orbits not very large. Not much lobed	*Monachus.*
Phocidæ with incisors $\frac{3}{2}$	PHOCINÆ.
Anterior nares very high. Molars little lobed	*Halichœrus.*
Anterior nares not very high. Molars considerably lobed	*Phoca.*

CHARACTERS OF THE PINNIPEDIA GENERALLY.

It may possibly be useful to enumerate the following characters which I have examined in different genera of Pinnipeds. Some of these are different in different groups, as has in part been already indicated.

(1) I have found no complete septum in the auditory bulla of any genus.

(2) The lip of the meatus auditorius externus projects greatly outwards in the *Phocidæ*; but it is not the median inferior part of the lip as in the Bears, but posteriorly as in the Otters. It is not prolonged outwards in the *Otariidæ* and *Trichechidæ*.

(3) The paroccipital process is more or less triangular, and directed outwards, downwards, and backwards, except in *Trichechus*, where it forms but a small buttress against, and uniting with, the hinder side of the great mastoid.

(4) The mastoid process may be considerably prominent (as in *Otaria*) or extremely so (as in *Trichechus*), or may form part of a wide-spread rounded prominence (as in the *Phocidæ*). It may form a continuous bone wall with the paroccipital process (as in *Otaria*), or be separated from it (as in the *Phocidæ*), or blend with it (as in *Trichechus*).

(5) The carotid foramen is always large and conspicuous, and is placed towards, or almost at the hinder end of, the bulla, which the carotid canal traverses, towards or along its inner margin—its course being indicated externally in *Otaria* and *Trichechus*, but not at all in the *Phocidæ*. It is never concealed (as it is in the Bears) by a projecting lip of the basi-occipital.

(6) The condyloid foramen is always distinct and exposed, and

never overlapped by a ridge of bone running from the par-occipital process to the condyle, and never opens into, though it appears sometimes to coalesce with, the foramen lacerum posterius.

(7) The glenoid foramen is always very small, and is sometimes not to be detected.

(8) The alisphenoid canal may be present or absent, as already mentioned more than once.

(9) The suborbital foramen is always rather large; but never as large relatively as in *Lutra* and *Enhydra*. It is largest in *Trichechus*.

(10) The frontal postorbital process present in *Otaria* and *Trichechus* is never more than a rudiment in the *Phocidæ*.

(11) The zygomatic postorbital process is formed both by the malar and squamosal in the *Phocidæ*, mainly by the malar in *Otaria*, and entirely by it in *Trichechus*.

(12) The alisphenoid and parietal always join by a narrow process of the latter bone.

(13) The premaxillæ never ascend to join the frontals.

(14) There is never a lachrymal foramen.

(15) The basis cranii is nearly always bent, so as to be convex downwards.

(16) The anterior nares are quite terminal in *Trichechus*, rather more distant from the end of the muzzle in *Otaria*, and not at all terminal, but looking more or less exteriorly upwards as well as forwards, in the *Phocidæ*.

(17) The opening represents both the foramen rotundum and the spheno-orbital fissure.

(18) The optic foramina open into the cranial cavity by a single aperture in *Otaria* and in *Stenorhynchus*, but not in the *Phocidæ* generally, as in *Trichechus*.

(19) The palate always extends backwards much behind the last molars, but is not commonly narrowed behind save in *Otaria*. It is not at all so narrowed in *Trichechus*.

(20) Defects of ossification commonly occur in the occipital in the *Phocidæ*, but not in *Otaria* and *Trichechus*.

(21) A preorbital process exists in *Otaria* and *Trichechus*; sometimes, but rarely, in the *Phocidæ*.

(22) The angle of the mandible is inflected (as in Marsupials) in *Otaria*, but not in the other genera.

It is now generally agreed to regard the Pinnipeds as derived from Ursine Arctoids; and there can be little doubt as to this origin as regards *Otaria*. But it is not absolutely necessary that the whole Order of Pinnipeds should have had but a single origin. It is at least conceivable that the Otaries might have been derived from Bear-like animals, while the *Phocidæ* had another, possibly a Lutrine, origin. If this hypothesis were correct, the Pinnipeds would of course consist of two strains which have gradually grown to be more and more alike. I have no intention of maintaining the probable

truth of the hypothesis; but, nevertheless, it may be well to enumerate the anatomical reasons which might be advanced in support of it:—

(1) In the *Phocidæ*, as in *Lutra*, there is no alisphenoid canal, while in both *Otaria* and *Ursus* it is present.

(2) In the *Phocidæ* and *Lutra* the paroccipital and mastoid processes are not united by a prominent ridge of bone, while in *Otaria* and *Ursus* they are so united.

(3) In the *Phocidæ* and *Lutra* the mastoid process does not much depend; in *Otaria* and *Ursus* it depends considerably.

(4) The bulla of *Lutra* could be easily made to resemble that of *Phoca* by giving a rounded form to the mastoid; in both genera there is the same sort of groove between the mastoid and the tympanic. The bulla of *Otaria*, on the contrary, is exceedingly like that of *Ursus*, and in both those genera the sort of groove which exists between the mastoid and tympanic in *Lutra* and *Phoca*, is absent.

(5) The angle of the mandible is very large in *Otaria* and *Ursus*, while in *Lutra* and *Phoca* it is smaller.

(6) The femur is very short in *Lutra* and *Phoca*; it is considerably longer relatively in *Otaria* and *Ursus*.

(7) In *Lutra* and *Enhydra* the floor of the orbit formed by the maxilla is very large, and it is also in *Leptonyx*, at least, amongst the *Phocidæ*, while in others of that family it is of moderate size. It is very small in *Otaria* and *Trichechus*, as it also is in *Ursus*.

(8) There are noteworthy defects of ossification in the cranial walls in *Lutra* and the *Phocidæ*. There are no such defects in *Ursus* or *Trichechus*, while they are but of small extent in *Otaria*.

(9) The suborbital foramen is very large in *Lutra* and *Phoca barbata* and *Trichechus*. It is small in the Bears, and of moderate size in most Otaries.

On the other side it may be urged that:—

(1) The postorbital process is formed entirely by the malar in *Otaria*, *Lutra*, and *Ursus*, while it is formed in part also by the squamosal in the *Phocidæ*—as it may be in *Canis*.

(2) There is a postorbital process to the frontal in *Lutra* and *Ursus* as well as in *Otaria*, while it is entirely, or all but entirely, absent in the *Phocidæ*.

The Distribution of the Pinnipedia.

The Pinnipeds are pretty equally divided between the Northern and Southern Hemispheres, there being about 14 northern and 11 southern species. Of the 9 genera, 5 (namely *Phoca*, *Halichœrus*, *Monachus*, *Cystophora*, and *Trichechus*) are northern forms, while *Stenorhynchus*, *Leptonyx*, and *Ommatophoca* are all three exclusively southern. *Macrorhinus* is equally divided, one of its species being northern and the other southern; while *Otaria* has three

northern and six southern species. In the Arctic and North Temperate zones we have all the species of *Phoca*; *Monachus* in the Mediterranean; *Cystophora* in the North Atlantic; and *Phoca* and two species of Otaries in the North Pacific. In the Indian Ocean we have one species of *Macrorhinus*. At the Cape of Good Hope we have an Otary. Two other Otaries are found about Australia and New Zealand. On the coast of Central America we have an Otary and *Macrorhinus*, while two other Otaries frequent the coasts of South America, and one inhabits the Aucklands. In the Southern and Antarctic Seas we have the two species of *Stenorhynchus*, with *Leptonyx*, *Ommatophoca*, a *Macrorhinus*, and an Otary.

A few species range over both the New and Old Worlds, in the Arctic region, and the opposite coasts of the North Atlantic and Pacific Oceans.

	Phoca vitulina.	*Steno-rhynchus leptonyx.*	*Cysto-phora cristata.*	*Otaria jubata.*	*Triche-chus.*
	"	"	"	"	"
Length of cervical region...	20·5	.....	.....	37·0	33·0
,, dorsal region ...	54·0	.....	.....	85·0	95·5
,, lumbar region ...	22·0	.....	.....	32·0	49·0
,, sacrum	12·5	.....	.....	17·0	22·0
,, caudal region ...	13·5	.....	.....	24·5	30·0
Length from atlas to end of sacrum	109·0	.....	.....	171·0	199·5
Length of pectoral limb ...	36·5	.....	.....	87·0	70·5
,, pelvic limb	56·5	.....	.....	85·0	104·5
,, humerus	11·0	.....	.....	23·0	30·5
,, radius	11·0	.....	.....	24·0	23·0
,, femur	10·0	.....	.....	17·0	24·0
,, tibia	21·7	.....	.....	28·0	34·5
,, 3rd metacarpal .	3·7	.....	.....	8·0	7·0
,, 3rd metatarsal...	5·1	.....	.....	10·0	11·7
,, 1st metacarpal...	5·0	.....	.....	15·0	10·0
,, 1st metatarsal...	7·4	.....	.....	12·5	12·0
,, 3rd phalanx of 3rd digit (manus).....	2·5	.....	.....	3·0	2·7
Length of 3rd phalanx of longest digit (manus) ...	2·7 (1st)	.....	.....	5·0 (2nd)	5·8 (1st)
Length of 3rd phalanx of 3rd digit (pes)	2·0	.....	.....	3·5	3·5
Length of 3rd phalanx of longest digit (pes).....	4·0 (1st)	.....	.....	5·0 (2nd)	3·3 (5th)
Basion to premaxilla	20·0	36·0	25·5	32·0	33·0
Length of palate	9·0	14·5	13·0	22·0	17·0
Breadth of palate	5·2	7·6	5·0	6·0	6·5
Greatest breadth of zygomata	12·8	19·4	21·5	22·5	22·7
Greatest breadth of brain case.....	9·6	13·0	12·5	10·2	16·5
Narrowest interorbital space	1·4	3·7	4·0	4·4	7·2
Length from canine to behind last lower molar ...	5·6	11·6	4·9	10·3	7·8
Length of $\frac{P.4}{}$	0·8	1·6	0·8	0·8	.....
Breadth of $\frac{P.4}{}$	0·4	0·9	0·5	0·6	.....
Length of $\frac{M.1}{}$	0·7	1·6	0·7	0·9	.....

Proportions borne to the spine from the atlas to the end of the sacrum, taken at 100, of:—

	Phoca.	*Otaria.*	*Trichechus.*
Cervical region	18·8	21·6	16·5
Dorsal region	49·5	49·7	47·8
Lumbar region	20·1	18·7	24·5
Sacral region	11·4	9·9	11·0
Caudal region	12·3	14·3	15·0
Pectoral limb	33·4	50·8	35·3
Pelvic limb	51·8	49·7	52·3
Humerus	10·0	13·4	15·2
Radius	10·0	14·0	11·7
Femur	9·1	9·9	12·0
Tibia	19·9	16·3	17·2
3rd metacarpal	3·3	4·6	3·5
3rd metatarsal	4·6	5·8	5·8
1st metacarpal	4·4	8·7	5·0
1st metatarsal	6·7	7·3	6·0
3rd phalanx of 3rd digit (manus)	2·2	1·7	1·3
3rd phalanx of longest digit (manus)	2·4	2·9	2·9
3rd phalanx of 3rd digit (pes)	1·8	2·0	1·7
3rd phalanx of longest digit (pes)	3·6	2·9	1·6
Basion to premaxilla	18·3	18·7	16·5
Length of palate	8·2	12·8	8·5
Breadth of palate	4·7	3·5	3·2
„ zygomata	11·7	13·1	11·3
„ brain-case	8·2	5·9	8·2
„ interorbital space	1·2	2·5	3·6
Length of lower dental series	5·1	6·0	3·9
Length of $\frac{P.4}{}$	0·7	0·4	.....
Breadth of $\frac{P.4}{}$	0·3	0·3	.....
Length of $\frac{P.4}{}$	0·6	0·5	.....

Proportions borne to the skull from basion to premaxilla, being taken at 100, of:—

	Phoca.	*Steno-rhynchus.*	*Cysto-phora.*	*Otaria.*	*Triche-chus.*
Length of palate	45·0	40·2	50·9	68·7	51·5
Breadth of palate	26·0	21·1	11·7	18·7	19·6
„ zygomata	64·0	53·8	84·3	70·3	68·7
„ brain-case	43·0	36·1	49·0	31·8	50·0
„ interorbital space	7·0	10·2	16·8	13·7	21·8
Length of lower dental series	28·0	32·2	19·2	32·1	23·6
Length of $\frac{P.4}{}$	4·0	4·4	3·1	2·5	.....
Breadth of $\frac{P.4}{}$	2·0	2·5	1·1	1·8	.....
Length of $\frac{M.1}{}$	3·5	4·4	2·7	2·8	.....